Vol. 117, No. 3 December, 1959

THE
BIOLOGICAL BULLETIN

PUBLISHED BY THE MARINE BIOLOGICAL LABORATORY

ON THE FOOD OF NUDIBRANCHS

IBRAHIM AHMED ABOUL-ELA

Faculty of Science, University of Cairo, Giza, Egypt

Apart from certain cases in which still little is known with certainty, our knowledge of the food of nudibranchs is very meagre. Likewise, the question of the food of many of them and its relation to their occasional disappearance by death or migration seem to be matters of confusion among many workers (Hecht, 1895; Chambers, 1934). At Al-Ghardaqa, where it has been possible to observe these animals in their natural habitat and to rear them in laboratory aquaria, advantage was taken to elucidate many points of interest in this regard.

Material and Methods

The species studied were collected from the tidal and subtidal coral patches in the immediate vicinity of the Marine Biological Station at Al-Ghardaqa on the Red Sea (27° 13′ N. Lat., and 34° 45′ E. Long.). The preferred habitat of these animals was found to be on dead coral skeleton overgrown by weeds. It is probable that these animals cannot stand strong light and high temperature for a long time, tending thus to hide by day in crevices. Hence, the best catches were those carried out in the early morning or about dusk. The animals were either killed and examined immediately after collection or reared in laboratory aquaria. The latter had a continuous current of sea water run through fine jets strong enough to form a cloud of air bubbles, thus ensuring perfect aeration and continuous movement of the water. In some aquaria pieces of living stony corals, as for instance *Favia, Goniopora, Coeloria,* as well as many forms of anemones, sponges, and algae, were introduced. Others were deprived of all kinds of food other than the planktonic content of the running sea water. A third group was supplied with sea water which had previously been passed through a cotton filter so as to keep back even planktonic organisms contained in the sea water. The last aquaria had been filled at the beginning of the experiment with filtered sea water so that the animals in them had nothing that they might feed on.

Results

Examination of the gut contents—or the wastes discharged at intervals through the anal aperture—of many of those species kept in the laboratory revealed exceedingly little, as they often contain practically nothing. On the other hand the in-

vestigation of the gut contents of some chromodorids—killed immediately after collection—does reveal the presence of diatoms and zooxanthellae. In one case of *Chromodoris pulchella,* the oesophagus was found to contain two polychaete postlarvae on their way to ingestion. Careful investigation of its stomach inclusions indicated the presence of small fragments, evidently of the same polychaete species, in various stages of digestion. Included in the gut, also, were a copepod and a considerable amount of calcareous spicules of sponges, as well as very few algal filaments. It seems probable that this individual was feeding on sponges when it ingested some of these polychaete larvae. In many specimens of *Chromodoris quadricolor, Chromodoris annulata* and *Chromodoris ghardaqana,* the gut contents showed nothing but unidentifiable fragments.

Two species of the nudibranch genus *Phyllodesmium* were found to be specific for browsing on *Xenia* and *Heteroxenia* at Al-Ghardaqa (Gohar, 1940; Gohar and Aboul-Ela, 1957b). In sections through their cerata, the latter were found to contain a great amount of zooxanthellae in their hepatic caeca. It would be well to mention here that these zooxanthellae are certainly derived from their alcyonarian food. Thus, when a specimen was taken from a colony of *Heteroxenia fuscescens* which had been kept for more than ten days in a dark room aquarium, it looked as pale as the colony. In sections the cerata were found practically devoid of zooxanthellae.

In another nudibranch—namely, *Dermatobranchus striatus*—the only substratum on which it has been observed is *Clavularia hamra.* Thus, several individuals of this nudibranch were picked out of freshly collected colonies of *Clavularia* immediately after their introduction into laboratory aquaria. The fact that it is always observed on this substratum has led to the conclusion that it is specific for browsing on *Clavularia.* It may be well to refer to the observations of Gohar (1948) in which he points out that *Pleuroleura striata* (a synonym of *Dermatobranchus striatus*) browses on the softer parts of that alcyonarian. In sections, nematocysts were observed in its skin and zooxanthellae in various stages of intracellular and extracellular digestion in its gut. Furthermore, the same author states (p. 22) that, "Both the nematocysts and zooxanthellae are evidently derived from the eaten-up polyps." Although Bergh (1905) gave a detailed description of this nudibranch, no mention was made of its substratum, its food or the possession of nematocysts and zooxanthellae.

By comparing the gut contents of many specimens with the food materials of their habitat, it is found difficult to tell what is actually made use of. To investigate the preferred food taken by some of the nudibranchs under investigation, feeding experiments, using the broth of various animals and plants, were conducted. The most interesting results were those obtained by using sea urchins' gonads, fish, various anemones, crustacean ova, sponges, alcyonarians and algae. Applying the broth of sea urchins' gonads with a pipette to the front end of *Chromodoris quadricolor* or *Chromodoris annulata,* the animal makes progressive movements towards the stimulus and works its oral apparatus continuously, sucking in the broth. When solid pieces of the same food were used, the radula—protruded through the dilated oral tube—is firmly applied to the food material. On retraction, the radular teeth puncture the superficial cells, the fluid contents of which are sucked into the buccal cavity by the muscular contraction and expansion of the buccal mass.

Similar results were obtained by using some algae and crustacean eggs, while the broth of anemones and fish particles—prepared in the same way—were refused.

Other nudibranchs like *Hexabranchus sanguineus* invariably refused all food of animal source but responded well to that of plant origin like pounded algae.

Under field conditions, large colonies of *Discodoris erythraeensis,* as well as the tectibranch *Berthellina citrina,* were found to disappear by the end of the breeding season from places where I used to find many of them, together with their spawn ribbons (Gohar and Aboul-Ela, 1957a; 1959). The same took place in the case of *Trevelyana bicolor,* of which twenty-three specimens and twenty-one of its egg-ribbons were collected on June 20, 1952, from a large colony at Qad El-Tair on the shore of Shadwan Island. A month later, a long search to find even a single specimen in this locality proved fruitless. In the laboratory, the animals supplied with most of the food they might have in their natural habitat could be kept in good health for several months. Several of them deposited their egg-ribbons more than twice during the experiment. Although some of the animals supplied with plankton, only, began to show signs of ill-health, others survived quite a long time and deposited their spawn ribbons. The individuals deprived of all kinds of food could hardly survive after the first week. The disappearance of the above colonies should not lead one, therefore, to assume that the animals die after oviposition but—being found accompanied by a large number of their egg-ribbons—it is most probable that they come near shore to spawn and migrate at the end of the breeding season to places where more favourable conditions prevail for the adults.

Discussion

The above observations demonstrate that many of the species investigated show a definite choice of their diet. Thus, while some forms like *Phyllodesmium xeniae* and *Dermatobranchus striatus* subsist mainly on animal matter, which in this case are the alcyonarians, many of the chromodorids here examined subsist for one part of their food on animal matter and for another part on plant diet. A third group like *Hexabranchus sanguineus* is entirely herbivorous, depending more or less completely on vegetable matter for food supply.

The absence of any appreciable amount of food material in the gut of many of the specimens investigated indicates that nudibranchs—as an adaptation to their sluggish life—have acquired the capacity of living on a minimal amount of food. Thus it may be that these animals under normal conditions do not, as a rule, take large amounts of food at one time but browse slowly, and that digestion proceeds as rapidly as ingestion resulting in very little, if any, food material in the guts of even freshly collected specimens.

The relation of food of nudibranchs to their occasional disappearance by death or migration is equally significant. According to one school of naturalists the disappearance of large colonies of nudibranchs can be explained as a result of a reduction in the food supply in a given locality, leading to their death or migration. Another school is of the opinion that this disappearance is primarily due to their immediate death after spawning. In the systematic literature, there is a widespread acceptance of supposed migratory phenomenon succeeding spawning and related processes.

Chambers (1934) recorded the sudden disappearance of *Embletonia fuscata* Gould, two weeks after the collection of several hundred individuals. His efforts to find even one specimen in the same locality were in vain, and this led him to assume the migration of the entire colony. In the opinion of this author such mysterious disappearances and reappearances of colonies at a locality—as recorded in the case of *Embletonia*—can be justifiably attributed to fatal environmental factors such as lack of food, extremes of temperature or the predominance of other life forms predaceous on nudibranchs. According to the same author, Hecht (1895), dealing with *Aeolidia papillosa*, concluded that death follows very shortly after spawning. However, several individuals of *Aeolida papillosa* kept in the laboratory aquaria were reported by Chambers (1934) to deposit their spawn and in no case did death follow oviposition.

In the light of our results, death did occur when the animals were deprived of any supply of suitable food materials, and did not result after reproduction and spawning. The latter processes have successfully been accomplished so long as food, temperature and other environmental conditions are favourable. In no case, whatsoever, did death follow oviposition in our aquaria, but migration may follow spawning in their natural habitat. Our observations, therefore, corroborate Chambers' view and shows that Hecht's conclusion—cited above—may be speculative rather than experimental.

Summary

1. Nudibranchs exercise considerable choice in the selection of their food. There is a complete chain of conditions from animals feeding exclusively on animal diet to animals depending more or less completely on algae for their food supply.

2. Deprived of all other kinds of food, nudibranchs can depend to a certain extent on suitable planktonic organisms for their diet.

3. Death of the animals does not follow reproduction and spawning, but results when the animals lack a suitable supply of food materials.

4. Large colonies of certain species may disappear as a result of migration after spawning to places where more favourable conditions of food, etc., prevail for the adults.

LITERATURE CITED

Bergh, R., 1905. Die Opisthobranchiata der Siboga Expedition. *Sib. Exped.*, 27: 1–248.

Chambers, L. A., 1934. Studies on the organs of reproduction in the Nudibranchiate Mollusks. *Bull. Amer. Mus. Nat. Hist.*, 66: 599–641.

Gohar, H. A. F., 1940. Studies on the Xeniidae of the Red Sea "Their Ecology, Physiology, Taxonomy and Phylogeny." *Publ. Mar. Biol. Stat. Al-Ghardaqa, Red Sea, Egypt*, 2: 25–118.

Gohar, H. A. F., 1948. A description and some biological studies of a new Alcyonarian species *Clavularia hamra* Gohar. *Publ. Mar. Biol. Stat. Al-Ghardaqa, Red Sea, Egypt*, 6: 3–33.

Gohar, H. A. F., and I. A. Aboul-Ela, 1957a. The development of *Berthellina citrina* (Mollusca, Opisthobranchiata). *Publ. Mar. Biol. Stat. Al-Ghardaqa, Red Sea, Egypt*, 9: 69–84.

Gohar, H. A. F., and I. A. Aboul-Ela, 1957b. On a new Nudibranch *Phyllodesmium xeniae*. *Publ. Mar. Biol. Stat. Al-Ghardaqa, Red Sea, Egypt*, 9: 131–144.

Gohar, H. A. F., and I. A. Aboul-Ela, 1959. On the biology of three Nudibranchs from the Red Sea. *Publ. Mar. Biol. Stat. Al-Ghardaqa, Red Sea, Egypt*, 10: 42–62.

Hecht, E., 1895. Contributions à l'étude des Nudibranches. *Mém. Soc. Zool. France*, 8: 539–711.